

AMSR-E

Sea Surface Temperature

1. Intent of This Document and Point of Contact (POC)

1a) This document is intended for users who wish to compare satellite derived observations with climate model output in the context of the CMIP5/IPCC historical experiments. Users are not expected to be experts in satellite derived Earth system observational data. This document summarizes essential information needed for comparing this dataset to climate model output. References are provided at the end of this document to additional information.

This NASA dataset is provided as part of an experimental activity to increase the usability of NASA satellite observational data for the modeling and model analysis communities. This is not a standard NASA satellite instrument product, but does represent an effort on behalf of data experts to identify a product that is appropriate for routine model evaluation. The data may have been reprocessed, reformatted, or created solely for comparisons with climate model output. Community feedback to improve and validate the dataset for modeling usage is appreciated. Email comments to HQ-CLIMATE-OBS@mail.nasa.gov.

Dataset File Name (as they appear on the Earth Science Grid, ESG) are:

tos_AMSRE_L3_v7_200206-201012.nc

tosNobs_AMSRE_L3_v7_200206-201012.nc

tosStderr_AMSRE_L3_v7_200206-201012.nc

1b) Technical point of contact for this dataset:

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support@remss.com

2. Data Field Description

| | |
|---|---|
| Climate and Forecast (CF) variable name, units: | tos, K tosNobs, number of observations tosstderr, K |
| Spatial resolution: | 1° x 1° |
| Temporal resolution and extent: | Monthly, June 2002 to December 2010 |
| Coverage: | Global |

3. Data Origin

The Advanced Microwave Scanning Radiometer (AMSR-E) for the Earth Observing System is a passive-microwave radiometer carried on NASA's AQUA satellite. AQUA's AMSR-E radiometer measures the Earth brightness temperatures at six frequencies in the microwave spectrum. Vertically and horizontally polarized measurements are taken at all channels but one. Calibration is accomplished with observation of cold (cosmic background radiation) and hot (on-board warm source) targets [2],[3].

AMSR-E measurements are sent from the National Space Development Agency of Japan (NASDA) Earth Observations Center (EOC) in Hatoyama, Japan to the Physical Oceanography DAAC at Jet Propulsion Laboratory. Data are then FTP pushed to Remote Sensing Systems (RSS) for further processing, as described below.

The transformation of satellite measured brightness temperatures to geophysical measurement is accomplished through careful calibration and retrieval algorithm development. The geophysical retrievals are determined using a radiative transfer model to simulate satellite measured brightness temperatures and derive a regression algorithm [4]. A large ensemble of ocean-atmosphere scenes is first assembled. Specification of the atmospheric scenes comes from quality-controlled radiosonde flights launched from small islands. A cloud layer of various columnar water densities ranging from 0 to 0.3 mm is superimposed on the radiosonde profiles. SST is randomly varied from 0 to 30°C, the wind speed is randomly varied from 0 to 20 m s⁻¹, and the wind direction is randomly varied from 0 to 360° [5].

The radiative transfer model uses these scenes to simulate the satellite measured brightness temperatures. A multiple linear regression algorithm is developed based on the relationship between known environmental parameters and simulated brightness temperatures. Algorithm testing is undertaken by repeating the process using the withheld scenes.

The satellite-measured sea surface temperature (SST) represents the temperature of the top layer of water, to approximately 1 millimeter depth. Therefore, the microwave SST retrievals are considered a sub-skin retrieval rather than a skin SST measurement. SST retrieval is prevented only in regions with sun-glint, rain, high wind speed (> 20 m/s) and near land or sea ice. Since only a small number of retrievals are unsuccessful, almost complete global coverage is achieved daily [3].

The AMSR-E version 7 SSTs from RSS are publicly and freely available from www.remss.com. Orbital files were specially processed into day and night monthly averages, number of observations, and standard error for this project. Further documentation on the RSS AMSR-E products is available from www.remss.com. The nighttime monthly averages were provided for model comparison in order to minimize any diurnal warming effects. The maps are 1°x1° spatial resolution. Data was binned and averaged into this 1°x1° grid.

4. Validation and Uncertainty Estimate

Buoy measurements from the Tropical Atmosphere Ocean / Triangle Trans-Ocean Buoy Network (TAO/TRITON) were used to validate the AMSR-E SSTs. The mean difference, satellite minus buoy SST, and standard deviation (STD) were calculated using

1 May 2002 through 9 June 2005. The TAO array shows AMSR-E to have very small biases (-0.03 C) and STD (0.41 C) [2].

5. Considerations for Model-Observation Comparisons

5.1 Time sampling bias

The sun synchronous orbit of AMSR-E yields retrievals at a local time of approximately 1:30 AM and 1:30 PM [5]. The diurnal cycle is not resolved or well measured by polar orbiting satellites because their sun-synchronous design results in the measurement of only 2 points of the diurnal cycle. In the case of AMSR-E, the diurnal cycle is measured at 1:30 AM and 1:30 PM (local time). To avoid the diurnal warming present in the daytime measurements, only the nighttime, or 1:30 AM, observations were included in the monthly averages.

5.2 Inhomogeneous sampling

The sampling is not globally homogeneous because of missing SST data, primarily due to rain. Some rain contaminated SSTs exist in AMSR-E data. At the edges of rain cells, there may be undetected rain that causes a biased SST retrieval. Version 7 AMSR-E SSTs has enhanced rain flagging to minimize this occurrence. Figure 1 below shows a lower number of observations along the equator. These low values are due to the Intertropical Convergence Zone (ITCZ) where strong convection leads to a region of increased precipitation. There is also an area in the Arctic where there is extremely high number of observations. At this latitude and above, the polar region is measured by almost every orbit. A similar occurrence happens at the southern pole but it is not seen because of land. There are also lower numbers of retrievals near the coastline of North America and around the European/Mediterranean regions. These are due to radio-frequency-interference from geostationary cable satellite transmissions, which can reflect off the ocean, back to the satellite, and contaminate the data. When this happens, data are flagged and removed from the data set.

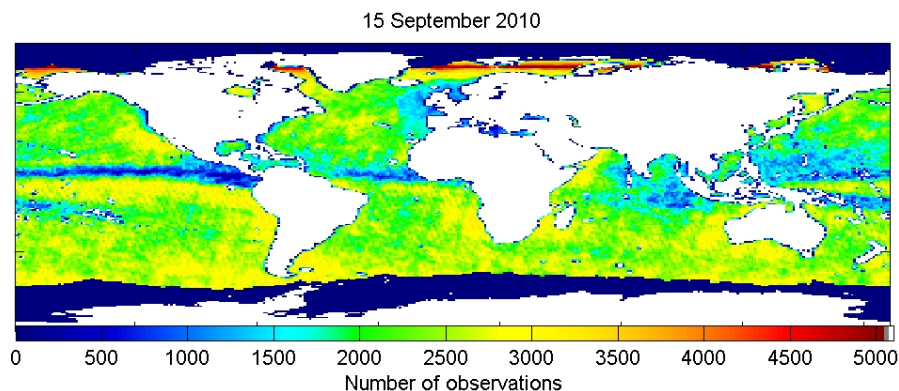


Figure 1: Number of SST observations included in the monthly average of September 2010.

5.3 Requirements for Ancillary Data Sets

The AMSR data processing has minimal requirements for ancillary data sets. Since wind direction in relationship to satellite look angle can impact the emissivity, wind direction is needed for the retrieval algorithm. Wind direction from NCEP GDAS analysis is

utilized [3]. Any error in specification of wind direction may result in the subsequent SST retrieval errors.

5.4 Missing Data

Satellite instrument data are occasionally unavailable. For those months with data gaps, there will be less total number of observations in the files. Known gaps are listed below.

| Date | Number of days |
|-------------------------|----------------|
| 2002.06.28 | 1 |
| 2002.07.30 - 2002.08.07 | 9 |
| 2002.09.13 - 2002.09.19 | 7 |
| 2003.10.30 - 2003.11.05 | 7 |
| 2004.11.19 | 1 |
| 2006.11.18 | 1 |
| 2007.11.27 - 2007.11.28 | 2 |
| 2010.02.02 - 2010.02.05 | 3 |

6. Instrument Overview

AMSR-E was launched on May 4, 2002, aboard NASA's Aqua spacecraft. Aqua is on a sun-synchronous orbit. It flies leading the satellite formation called the "A Train" with several other satellites (Figure 2). The A-Train or, Afternoon Train, satellites cross the equator, from south to north, within a few minutes of each other at around 1:30 p.m. local time. The National Space Development Agency of Japan (NASDA) provided AMSR-E to NASA as an indispensable part of Aqua's global hydrology mission. Over the oceans, AMSR-E is measuring a number of important geophysical parameters, including SST, wind speed, atmospheric water vapor, cloud water, and rain rate. A key feature of AMSR-E is its capability to see through clouds, thereby providing an uninterrupted view of global SST and surface wind fields[5].

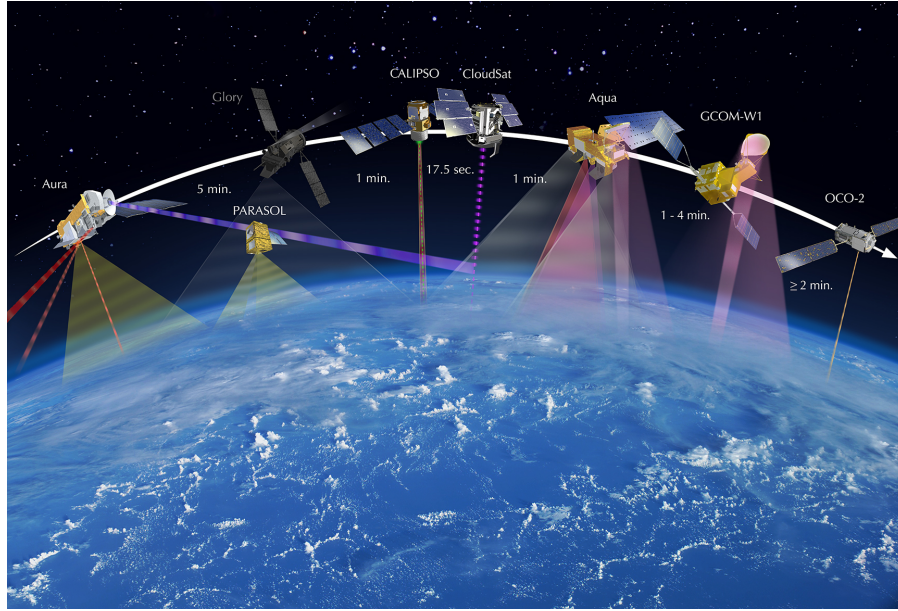


Figure 2: A-train satellite constellation. AMSR-E is onboard AQUA.

7. References

- [1] <http://nsidc.org/data/amsrell1a.html>
- [2] Gentemann, C. L., F. J. Wentz, M. Brewer, K. A. Hilburn and D. K. Smith, [Passive microwave remote sensing of the ocean: An overview, in Oceanography from Space](#), Revisited, edited by V. Barale, J. F. R. Gower and L. Alberotanza, pp. 13-33, Springer, Heidelberg, 2010.
- [3] Wentz, F. J. and T. Meissner, (2007), [AMSR-E Ocean Algorithms; Supplement 1, vol. 051707](#), p. 6, Remote Sensing Systems, Santa Rosa, CA.
- [4] Wentz, F. J., (1998), [AMSR Ocean Algorithm, vol. 110398](#), p. 66, Remote Sensing Systems, Santa Rosa, CA.
- [5] Parkinson, C. L., (2003) [Aqua: An Earth-Observing Satellite Mission to Examine Water and Other Climate Variables](#), *IEEE Transactions on Geoscience and Remote Sensing*, 41(2), 173-183.

8. Revision History

Rev 0 – Monday, October 31, 2011